BENEFITS

- **Streamlined:** Decreases complexity and lessens the weight impact on flight payloads through the use of small, lightweight fiber optics

- **Robust:** Offers real-time displays of key data points, including wing motion and deflection

- **Precise:** Provides detailed measurements during flight, providing the capability to reduce drag and make other real-time adjustments

- **Safety-enhancing:** Helps aircraft controllers and pilots monitor the structural integrity of aircraft in flight, potentially improving safety

- **Economical:** Helps to reduce wing load and alleviate drag, which can help to minimize fuel consumption over the course of a flight

technology solution

Sensors

Computation of Wing Deflection and Slope from Measured Strain

New NASA methodology computes detailed wing loads during actual flight

Researchers at NASA's Armstrong Flight Research Center have developed a revolutionary new method to compute wing deflection and slope from measured strain of an aircraft during flight. The technology is based on a lightweight, robust fiber optic system that is small, easy to install, and fast. It offers the first-ever means of obtaining real-time strain measurements while an aircraft is in flight. Such measurements are particularly useful for real-time virtual displays of wing motion; aircraft structural integrity monitoring; and actively reducing drag, controlling flexible motion, and alleviating loads.
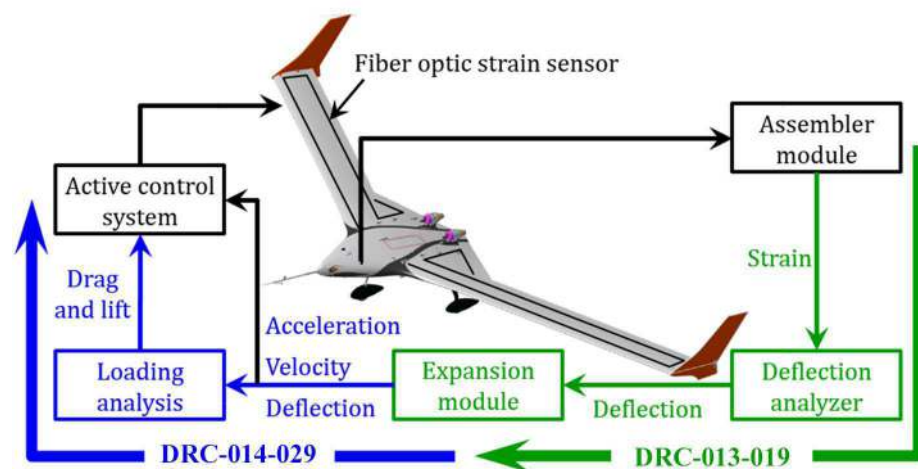
THE TECHNOLOGY

Armstrong's technology can be used to calculate a variety of critical parameters with specific wing deflection and slope measurements, including complete degrees of freedom—that is, three translational degrees of freedom (tx, ty, and tz) and three rotational degrees of freedom (rx, ry, and rz).

From measured strain, a computer program calculates wing deflection and slope along the line of the fiber optic strain sensor. This enables real-time virtual displays of wing motion as well as accurate measurements of wing load.

Accurately computing the load on the aircraft wing requires complete degrees of freedom at all structural finite element nodal points. Traditional methods are capable of measuring only sectional loads over the wing, without discerning between inertia load, drag load, etc. Armstrong's approach enables measurement of the load over the entire wing, and it enables differentiation between different types of load. This has the potential to reduce fuel consumption by reducing structural weight through the use of active flexible motion control and by reducing wing-drag load.

Wing deflections are typically computed from the strain on the wing, which is traditionally measured using a strain gauge. However, such an approach requires measurements of multiple strain gauges over the wing, each requiring multiple wires. This increases weight and complexity, and makes the measurement unwieldy in many applications with limited space. By contrast, Armstrong's technology requires only one wire per fiber optic strain sensor for accurate measurement, decreasing weight and improving applicability.

Active induced drag control to reduce fuel consumption

APPLICATIONS

The technology has several potential applications:

- Real-time virtual display of wing motion
- Structural health monitoring
- Active drag reduction
- Active flexible motion control
- Active loads alleviation
- Other applications in aerospace, aeronautics, and mechanical engineering

PUBLICATIONS

Patent Pending

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

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